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WO 96/23142 A1 US 4874275 A

(58) Field of Search
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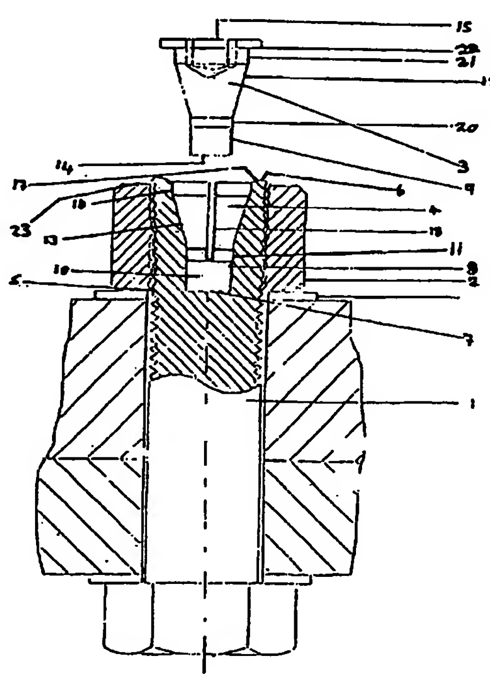
(54) Abstract Title
Locking threaded elements

(57) A locking device comprises a threaded bolt or stud 1 having a tapered axial recess 4 at one end which extends into an axial threaded bore 8. Radial slits 18 extend from the recess 4 so that when a tapered insert 3 is screwed into the bore 8, it engages the recess 4 and expands the end of the bolt 1 into locking contact with a female threaded element 2 screwed thereon. Alternatively, the tapered insert (26, Fig 8) may be splined into the recess (27) and drawn in by a threaded rod (47) extending through an axial bore from the head of the bolt (37). In another embodiment the bolt 1 may not be externally threaded.

FIG.1



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SHEET 1.14

FIG.1

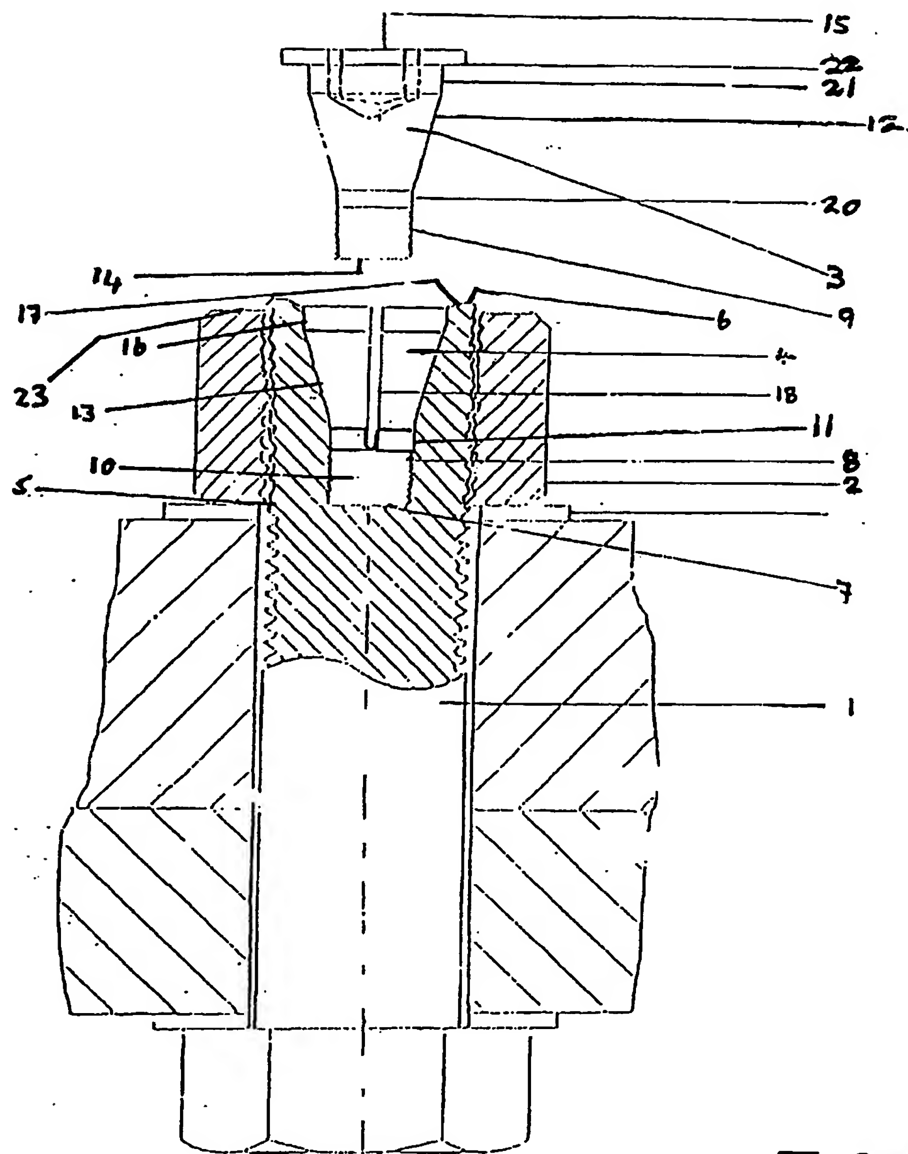
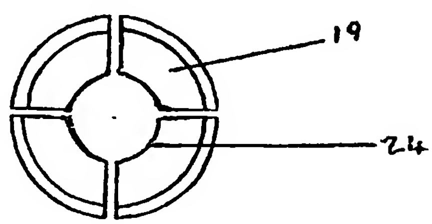
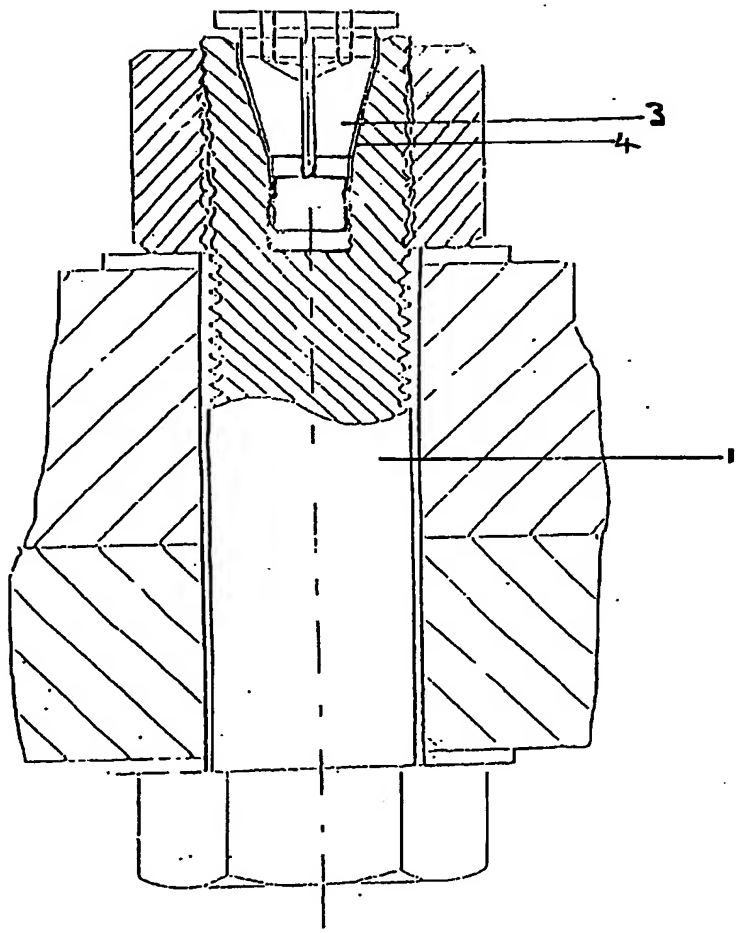


FIG.1A



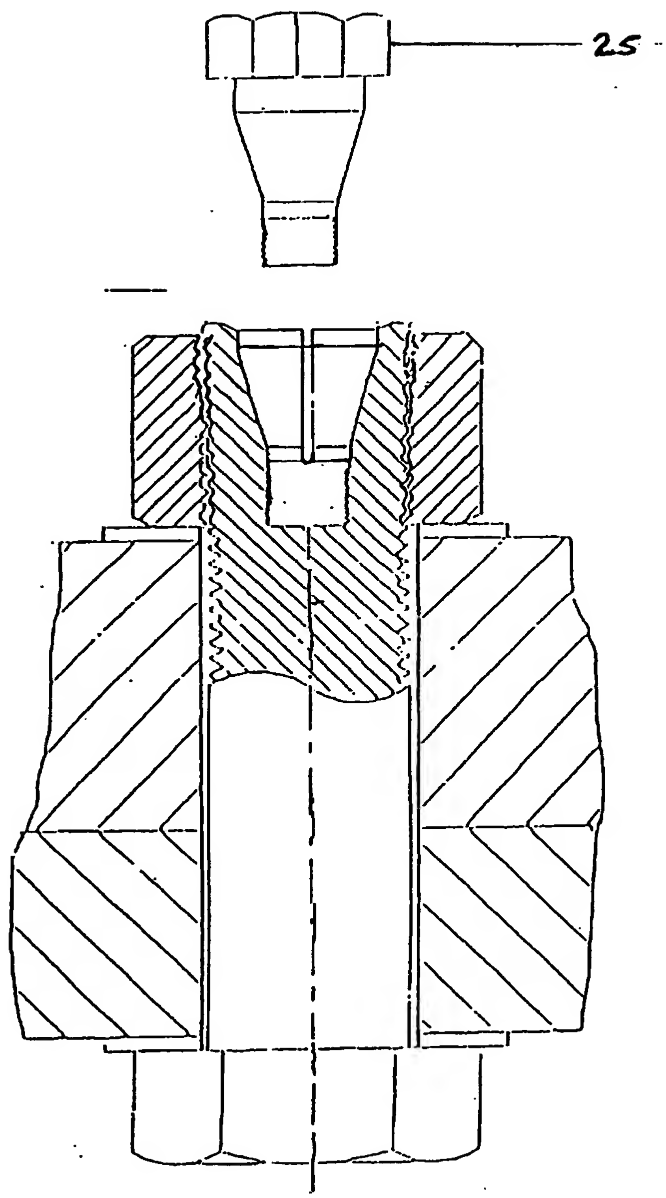
SHEET 2.14

FIG.2



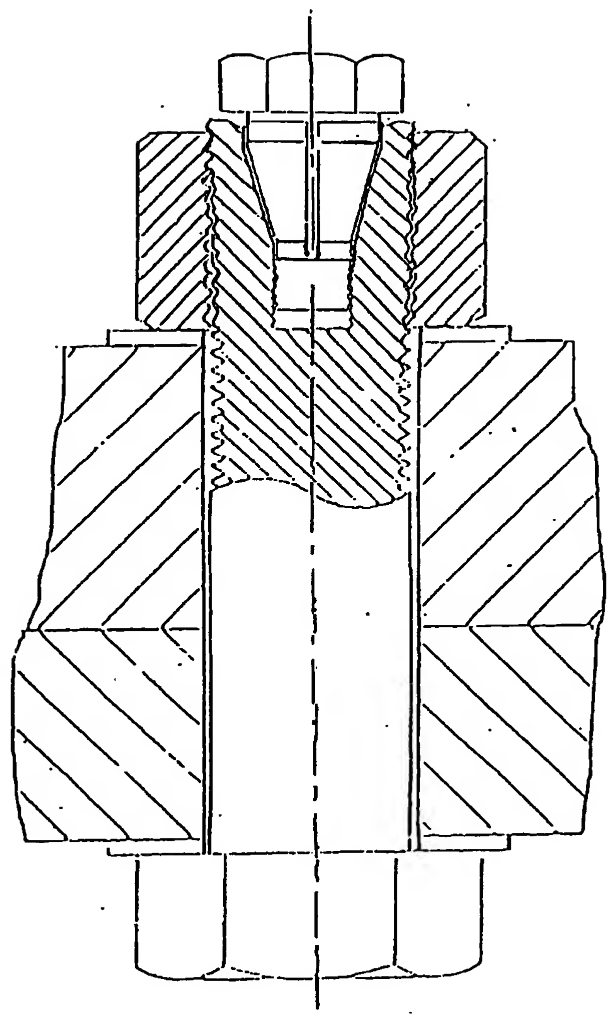
SHEET 3.14

FIG.3



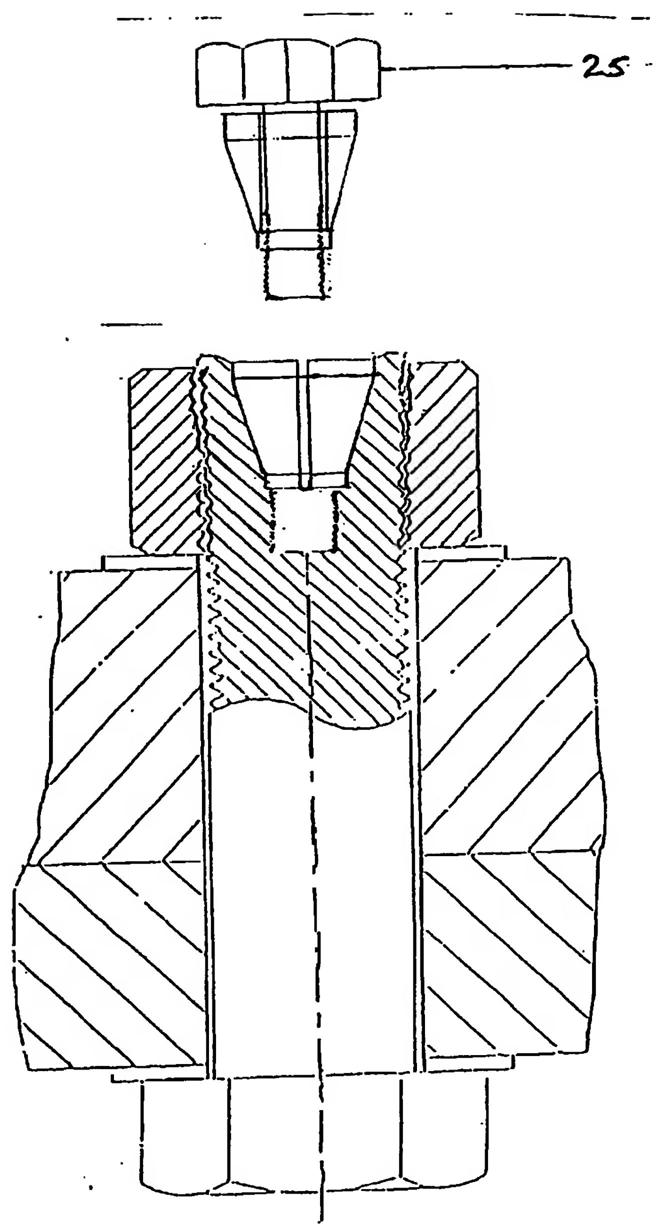
SHEET 4.14

FIG.4



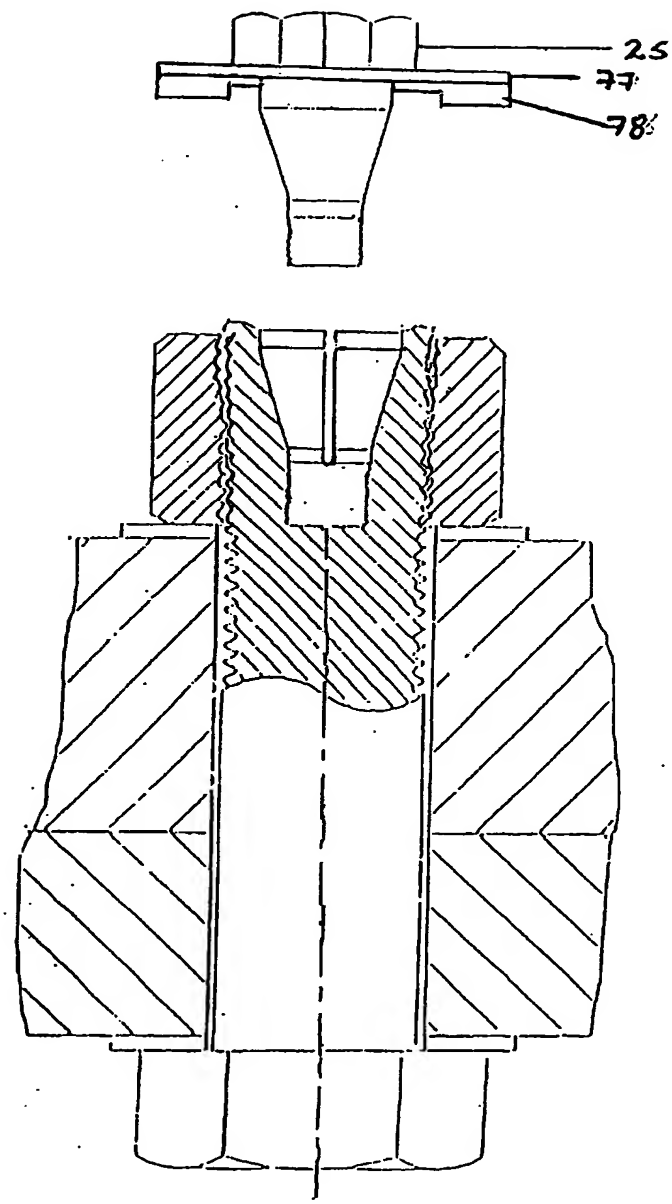
SHEET 5.14

FIG.5



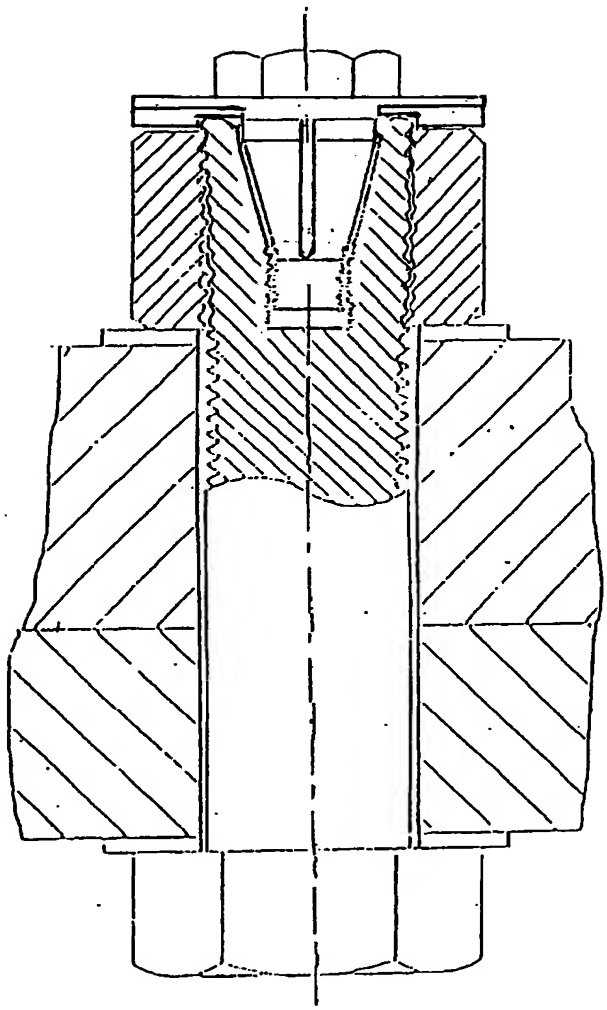
SHEET 6.14

FIG.6

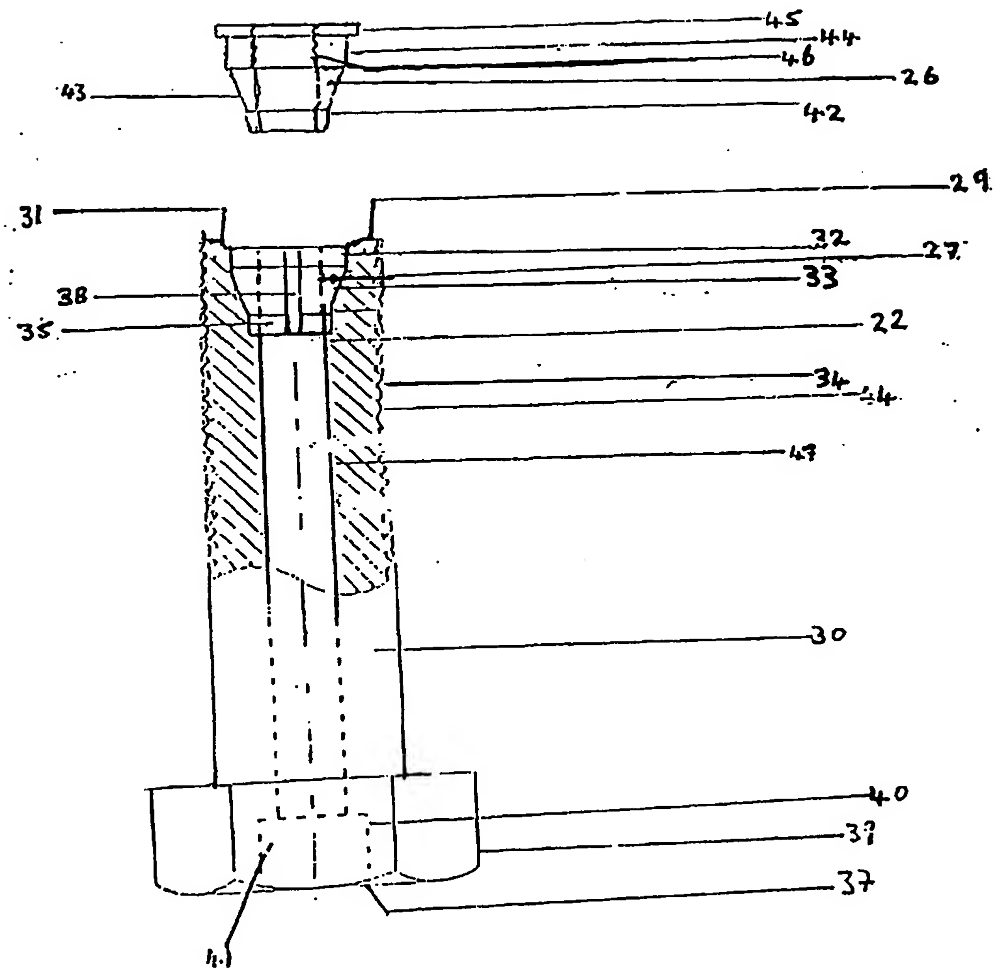


SHEET 7.14

FIG.7

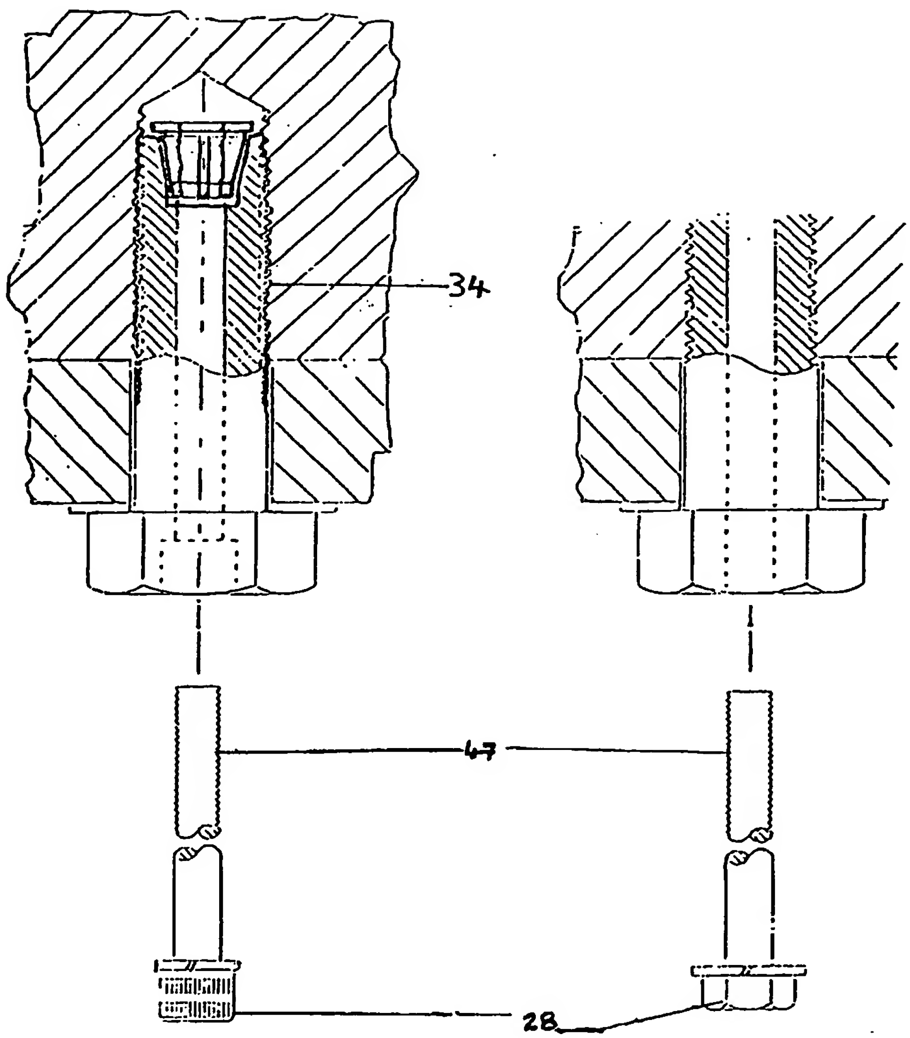


SHEET 8.14 FIG.8



SHEET 9.14

FIG.9



SHEET 10.14

FIG.10

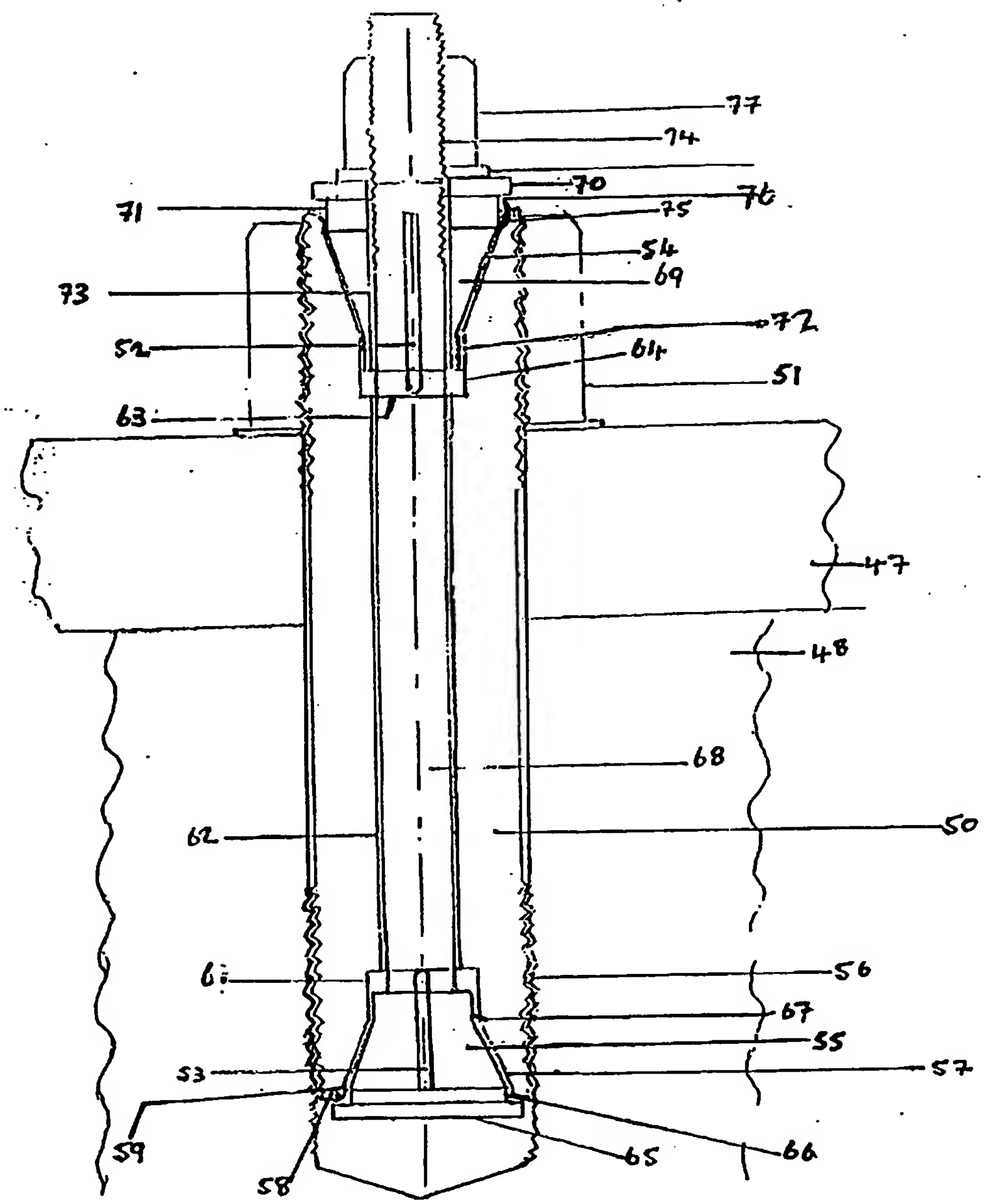
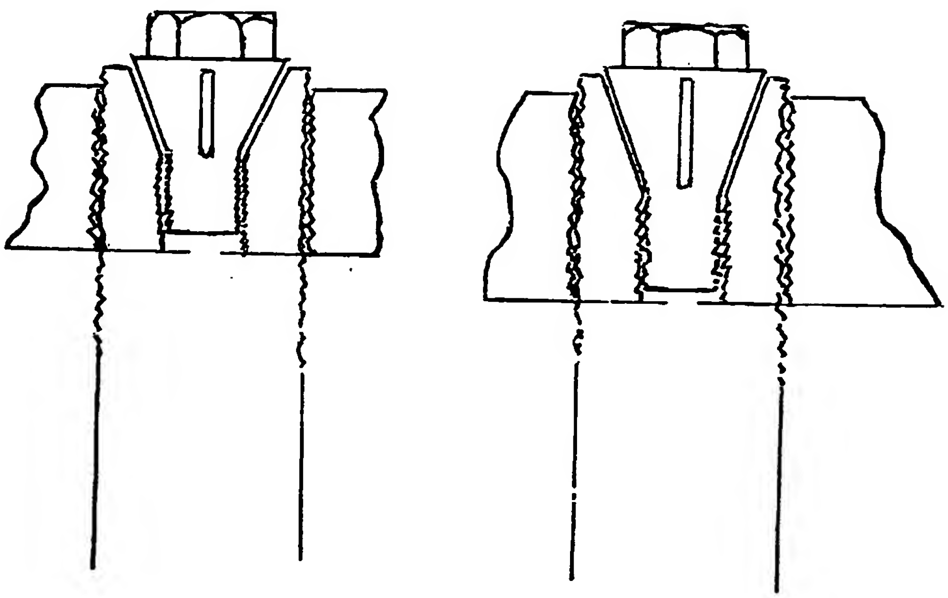
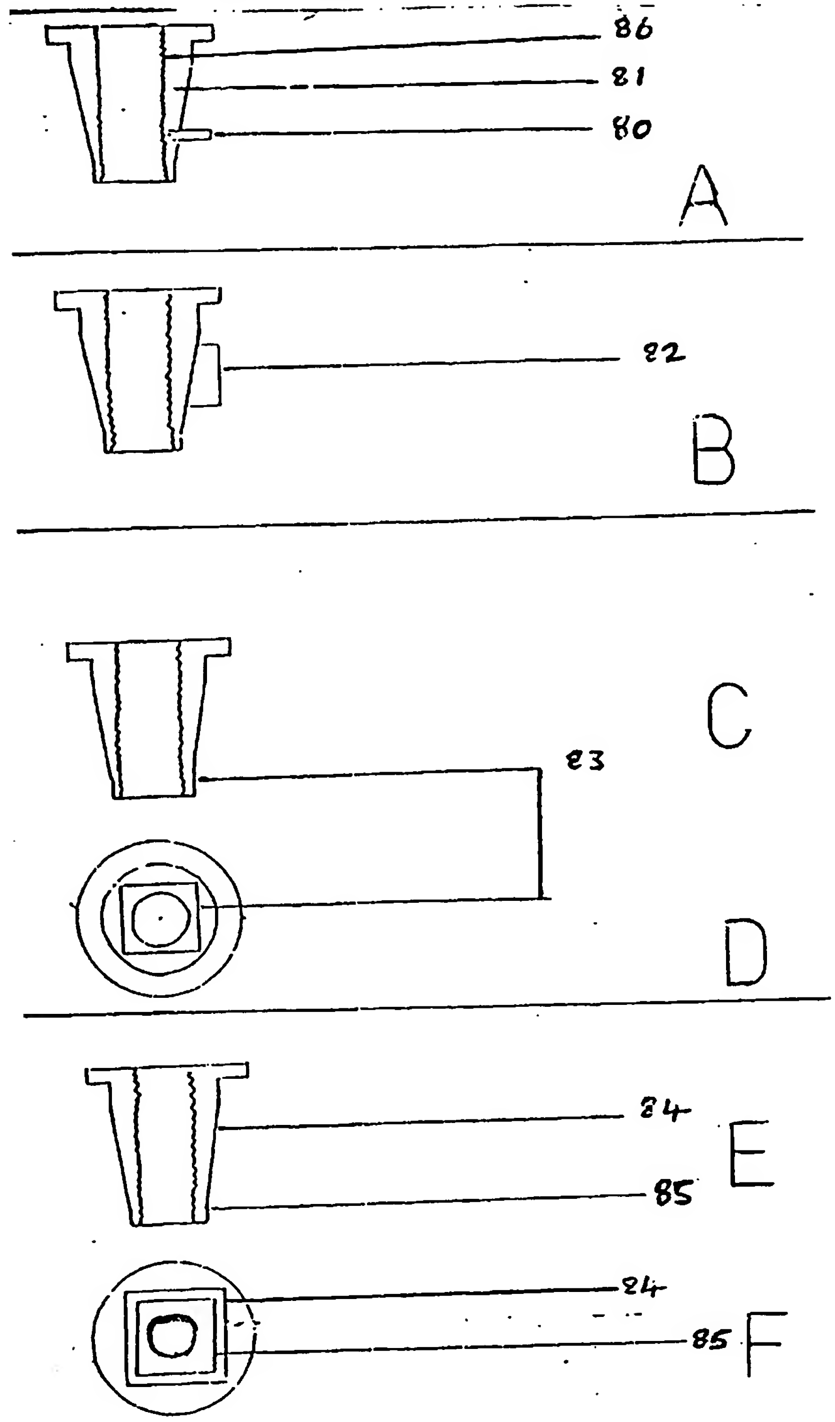


FIG.11

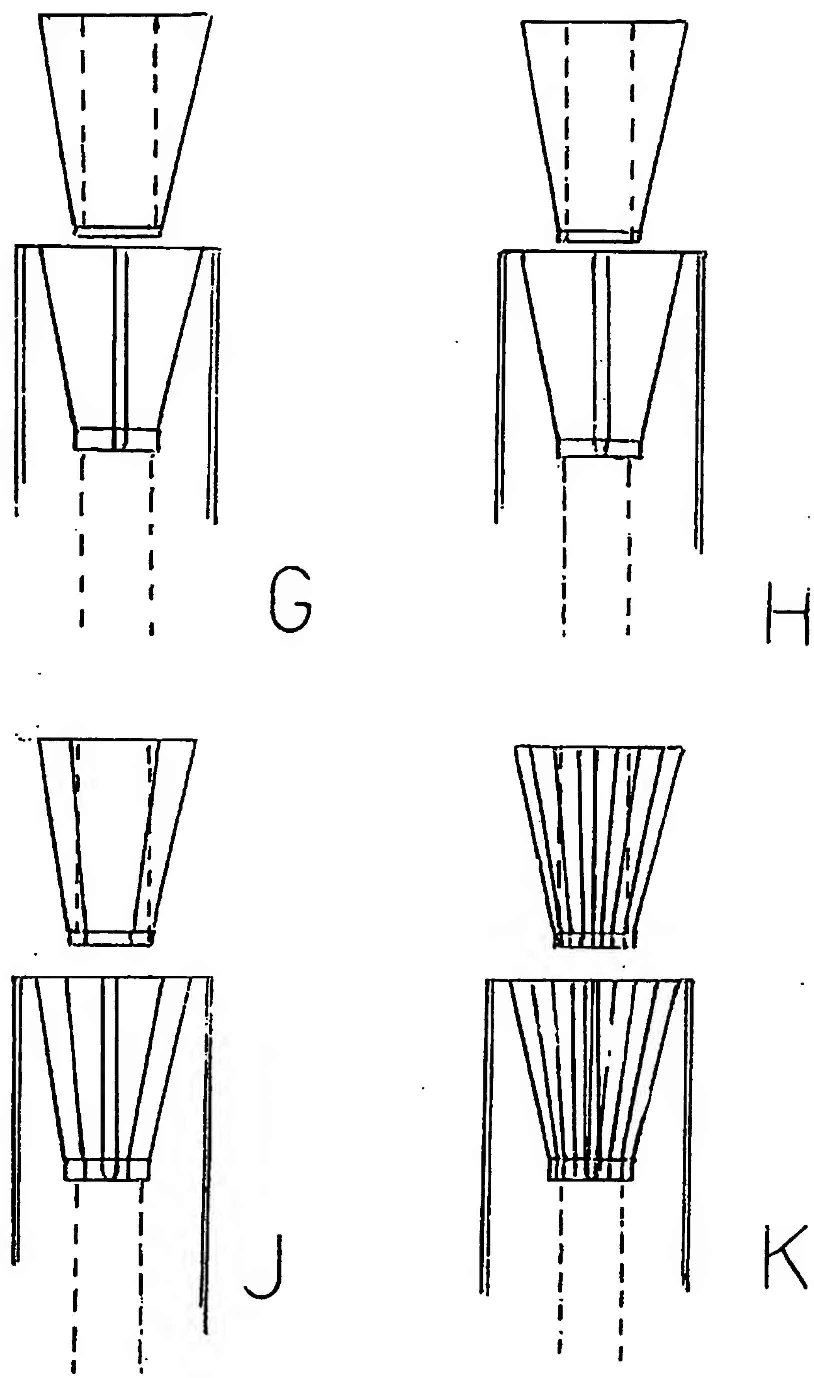


SHEET 12.14 FIG.12



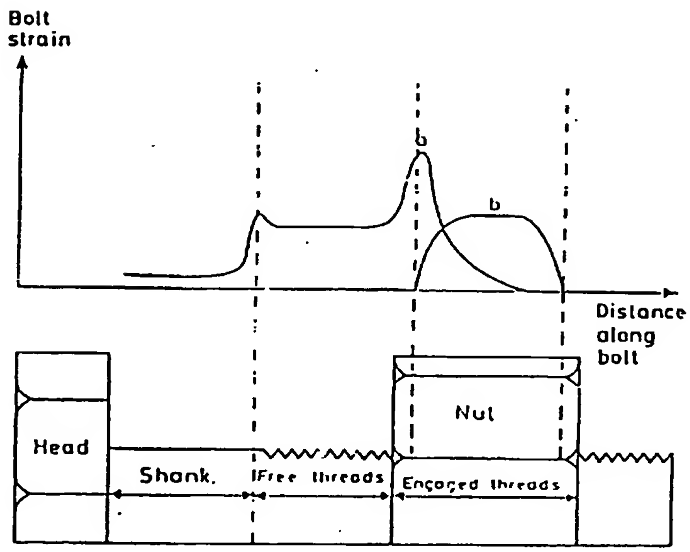
SHEET 13.14

FIG.13



SHEET 14.14

FIG.14



a = Bolt axis strain

b = Engaged thread interface

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IMPROVEMENTS RELATING TO FASTENER SECURING METHODS

This invention relates to improvements of securing methods for male threaded fasteners generally but not exclusively where the extreme threaded or plain end is recessed, split and caused to expand radially.

The purpose of male threaded fasteners is to clamp two or more parts together. The clamping load stretches or elongates the male threaded fastener, the load being usually obtained by rotating the nut on the thread, until the male fastener has elongated almost to the elastic limit. During tightening the first thread of the nut tends to take the entire load - see Fig.14, but yielding occurs, with some cold work strengthening taking place, until the load is eventually divided over about three nut threads depending upon the ability of the threads to flow in compression. The maximum strain on the male threaded fastener thus exists at the first nut thread interface. The larger the cross sectional area of the male threaded fastener the larger the load able to be applied and supported. If this pre-load or clamping load remains in excess of the work load and if the nut does not loosen, the joint will remain tight. However, threaded fasteners lose their tension for a variety of reasons but some of the most common ones are vibration and impact.

Dynamic loading creates radial sliding movements at the mating thread interfaces and if this is transverse the movement can be of the magnitude of the maximum allowed thread tolerances. This occurs more often in practice than is admitted and the overall effect is fastener loosening, resulting in the loss of thousands of pounds and hundreds of man hours in plant maintenance and equipment down time.

Various methods exist to prevent fastener loosening such as the use of spring washers, lock nuts and adhesive fillers and although all have some merits they are not completely reliable and are sometimes difficult to disassemble especially if they have been used in corrosive or dirty environments.

It has been known for over a hundred years that male threaded fasteners could be secured in position within female threaded fasteners by inducing segments at the extreme threaded end of the male fastener to expand radially using frusto conical inserts. Numerous improvements followed but difficulties still prevailed when the optimum load was applied and subsequent disassembly attempted.

Objects of the invention, therefore, are to provide securing features for male threaded fasteners, when used in conjunction with female threaded fasteners, whether the fastening assembly is a "nut and bolt" or "tapped hole" type, that are reliable, easily manufactured, simple and quick to install and release, able to be prevented from being overtightened while allowing the optimum amount of load to be applied to prevent assembly loosening or premature fracturing and to be re-usable.

Other objects, uses and advantages of the invention will become apparent to those skilled in the art from the following description, claims and accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a section of a primary male threaded fastener and nut showing an exploded view of the socket drive insert and recess in accordance with the present invention.

Figure 1a shows a plan view of the threaded end of the MTF.

Figure 2 is a section of the primary male threaded fastener and nut showing the socket drive insert fully engaged in the recess of the primary male threaded fastener.

Figure 3 is a section of a primary male threaded fastener and nut showing an exploded view of the external hexagon head drive facility.

Figure 4 is a section of the primary male threaded fastener and nut showing the external hexagon head drive insert fully engaged in the recess of the primary male threaded fastener.

Figure 5 is a section of a further embodiment of a "nut and bolt" situation where the insert consists of separate components.

Figure 6 is a section of the primary male threaded fastener and nut showing an exploded view of the modified insert used to reduce moisture and dirt ingress.

Figure 7 is a section of the primary male threaded fastener and nut showing the modified external hexagon head drive insert fully engaged in the recess of the primary male threaded fastener.

Figure 8 is a section of the primary male threaded fastener and insert in an exploded view as would be utilised in a "tapped hole" situation or a "nut and bolt" situation where the nut is difficult to access and apply torque.

Figure 9 is a section of the primary male threaded fastener and insert fully engaged in a "tapped hole" situation.

Figure 10 is a section of a fully engaged engineers' stud and insert showing modifications to both ends of the stud.

Figure 11 showing sections of male threaded fasteners in "nut and bolt" situations where nut thicknesses are different.

Figures 12A to 12F sections and plans of various types of insert to be used with secondary male threaded fasteners showing some anti-rotational devices.

Figure 13G to 13K sections of various inserts and recesses used in "tapped hole" situations.

Figure 14 diagram of bolt strain with respect to distance along bolt with nut engaged.

DESCRIPTION OF EMBODIMENTS

Figure 1 shows the components used in the "nut and bolt" application where the primary male threaded fastener (MTF) is a bolt (1) although any other MTF such as a set screw, socket cap screw, wheel stud, engineer's stud, threaded rod etc. could be used and the female threaded fastener (FTF) is a hexagon nut (2) although any other any other open external form could be used.

The insert (3), whose general shape will be discussed later, is in this case of the hexagon socket drive type although any form of internal drive could be used e.g.. square, cross, spline etc. while the corresponding recess (4) in the threaded end of the MTF (1) is of similar form.

Since, under recommended clamping conditions between MTF's and open FTF's, the maximum strain occurs in the vicinity of the first engaged thread (5) of the open FTF (2) it is necessary to ensure that this position coincides with the maximum cross sectional area available in the clamped portion of the MTF (1). Hence, although various positions of the end of the recess can be chosen the ones that ensure the most effective clamping are the ones that do not extend beyond the end of the open FTF (2) furthest away from the extreme threaded end (6) of the MTF (1). In this position it is normal engineering practice to have one or two threads of the MTF (1) extending beyond the end of the open FTF (2) at the extreme threaded end (6) of the MTF(1).

The end (7) of the recess (4) furthest away from the extreme threaded end (6) of the MTF (1) is provided with an internal thread (8) whose length and thread form must be mechanically and physically compatible with the threaded spigot (9) of the insert (3) (see later description.) This threaded portion in this diagram then leads into a plain cylindrical bore (11), which can sometimes be an alignment aid, although this is optional depending on the space available within the depth of the FTF (2) (see Figure showing thinner nut.) This cylindrical bore (11) then leads into a frusto conical portion (13) whose widest part is nearest the extreme threaded end (6) of the MTF (1). The included angle of the conical portion can vary depending on the distance between the extreme threaded end (6) of the MTF (1) and the position of the first thread of engagement (5) of the open FTF (2) after the load has been applied to the MTF (1). Irrespective of the included angle of the frusto conical section (13) it is vital to the efficient functioning of the invention that the included angle is less than that of the frusto conical section (12) of the insert (3). The final stage of the recess (4) shown in this diagram comprises a cylindrical bore (16) that joins the widest end of the frusto cone (13) to the extreme threaded end (6) of the MTF (1) with the extreme threaded end face (6) provided with a radius or chamfer (17). Both the final cylindrical bore (16) and the chamfer (17) are useful additions to aid the concentricity of the radial expansion but can be eliminated depending on space available within the open FTF (2). Concentricity can be ensured by other means.

The end of the MTF (1) containing the recess (4) has narrow slots (18) running in the axial direction which are spaced circumferentially to allow radial expansion of the extreme threaded end (6)of the MTF (1) when the insert (3) is screwed into the recess (4). The number of slots can vary depending on the wall thickness of the segments,

and the stiffness or rigidity of the material from which the MTF (1) is manufactured. The distance from the extreme end (6) of the MTF (1) to where the slots (18) extend is variable but the most effective end point is at the end of the threaded portion of the recess (4) nearest to the extreme threaded end (6) of the MTF (1). Although the ends of the slots can be radiused to prevent stress concentrations it is not vital for the functioning of the invention.

To ensure the securing function of the invention there fits within the recess (4) an insert (3), one end of which carries a threaded spigot (9) which engages with the internally threaded section (8) of the recess (4). Following on from the threaded portion (9) is an optional plain cylindrical register (20). This embodiment assists in the location of the insert (3) within the recess (4) but is not vital to the operation of the invention. In fact from a manufacturing point of view it is sometimes easier to undercut the insert (3) between the threaded portion (9) and the frusto conical portion (12). This frusto conical portion (12) of the insert (3) is of the same basic form as that of the recess (4) but it is crucial to the effective operation of the invention that the included angle of the frusto cone (12) of the insert (3) is greater than that of the recess (4). Following on from the largest diameter of the frusto conical section (12) of the insert (3) is an optional plain cylindrical register (21) which links with an optional abutment (22). The cylindrical register (21) is slightly greater in diameter than the corresponding cylindrical bore (16) in the recess (4) and is an aid to concentricity but is not vital to the operation of the invention. Because of the commercial tolerances and low mechanical properties of some grades of threaded fasteners the abutment (22) can be useful as a prevention against overtightening If the abutment (22) touches the extreme end (6) of the MTF (1) the tightening may be incomplete and unreliable.

Figure 2 shows the socket drive insert (3) fully engaged in the recess (4) of the MTF (1).

The preferred method of installation and assembly of the invention is to ensure the insert (3) is screwed into the recess (4) "finger tight" before any load is applied to the FTF (2). When the insert (3) is in place "finger tight" the recommended torque or other method of load application is applied to the FTF (2) and because of the position of the recess (4), and slots (18), premature fracture will not occur during tightening. The recommended torque can then be applied to the insert (3) such that the segments (19) shown in Figure 1a splay outwards and the male and female threads of the MTF (1) and FTF (2) are forced into each other eliminating any clearance and preventing lateral movement at the thread interfaces when in use. The fully secured system is shown with the concentricity registers (20,21) fully engaged in the corresponding cylinders (11,16), the surfaces of the frusto conical portions (12,13) of the insert (3) and recess (4) touching along their length, the abutment (22) being clear of the extreme end (6) of the MTF (1) and the end of the threaded spigot (9) furthest away from the driving end (15) of the insert (3) being clear of the end of the threaded portion (7) of the recess (4) furthest away from the extreme threaded end (6) of the MTF (1), and is not extending beyond the first thread of engagement (5) of the FTF (2).

The expandable segments (19) of the MTF(1) bend or rotate about flexure hinges (24), also shown in Figure 1a, as the insert (3) is screwed into the recess (4), such that their

maximum displacement is at the extreme end (23) of the FTF (2), where ideally one or two threads will protrude beyond the end (23) of the open FTF (2). In order to effect this bending of the segments (19) it is necessary to overcome the bending resistance by ensuring that the threaded insert (3) and recess (4) are compatible mechanically and that the thread length, diameter and mechanical strength are sufficient to sustain the load placed upon them during operation.

Disassembly of "the nut and bolt" components is carried out by first loosening the insert (3) from the recess (4). The FTF (2) is then released and removal from the MTF (1) is easier if the diameter of the abutment (22) is less than the thread diameter of the FTF (2). However, to those skilled in the art a number of other options for this design are easily manufactured.

Figures 3 and 4 show how other types of drive can be used on the insert e.g. external hexagon head (25) or other polygonal drive systems such as square, splined etc.

Figure 5 shows a further embodiment of a "nut and bolt" situation where the insert consists of a frusto conical and cylindrical register form having along its axis a plain bore through which the shank of a hex head bolt in this case is fitted such that the threaded end of the bolt, in this case, then screws into the threaded portion of the recess activating the extreme end of the MTF as already previously described.

Figures 6 and 7 show a modification to the hex head insert in the "nut and bolt" application whereby a steel washer (77) is placed under the hex head (25) and under this steel washer (77) is placed a shaped soft gasket (78) or similar which compresses onto the extreme ends of the primary MTF and FTF when the insert is screwed into the recess. To those skilled in the art other variations can be manufactured.

As indicated earlier this invention can be applied to fastening systems when the MTF (30) to be modified is screwed into a tapped blind hole. Such depictions are shown in Figure 8 and 9. The principle of the crests of the threads of the MTF (30) being forced into the roots of the threads of the FTF (34) is the same as in the "nut and bolt" example whereby the thread clearances are eliminated and lateral movement is prevented, but the introduction of the insert (26) into the recess (27) is carried out in a different manner using a secondary MTF (47), see Figure 9. This system can also be used in a "nut and bolt" situation where the nut is difficult to access. In this case the tightening operation takes place from the head end of the primary MTF. The secondary MTF is then tightened as described later.

From the threaded end face (29) of the primary MTF (30) in Figure 5 the recess (27) begins with an optional chamfer (31) leading into an optional plain cylinder (32) which continues into the largest diameter of the frusto conical portion (33). The included angle and length of this frusto cone (33) depend upon the amount of thread engagement between the primary MTF (30) and the tapped blind hole (34) and the radial movement necessary between the primary MTF (30) and the recess end of the tapped blind hole (34) to eliminate any clearance at the thread interfaces and prevent any lateral movement between them when the male and female threads are forced into each other to ensure security and resistance to loosening. Although a frusto conical

recess has been described there are other forms of recess which can be utilised which are shown in Figure 13 and which will be described later. Continuing from the smaller diameter end of the frusto conical recess is a square or other polygonal, or splined or knurled recess which acts as an anti rotational device for the insert which will be described later. Continuing from this recess and blending into it is a central bore that exits at the other extreme end of the primary MTF (30) . The extreme threaded end (29) of the MTF (30) has slots (38) as previously described with the slots terminating at the start of the central bore (22). Into this bore (22) along the axis of the primary MTF (30) fits a secondary MTF (47) - see Fig.9. If the primary MTF (30) is, for example, a hex head bolt or set screw then the secondary MTF (47) is introduced into the axial bore (22) of the primary MTF (30) from the head end (37) until the head (28) of the secondary MTF (47) rests against the head (37) of the primary MTF (30). The head (28) of the secondary MTF (47) could be hexagon or any other external polygonal form or could be a socket cap screw or any other internal polygon drive form. The heads (37) of the primary MTF's (30) could be counterbored to accept the heads (28) of the secondary MTF's (47) if so desired. If the primary MTF (30) was a socket cap screw or similar the secondary MTF (47) would usually be a socket cap screw or similar, of smaller diameter, and fitted into a counterbore within the socket head, or similar, of the principal MTF (30) However, those skilled in the art could apply any form of combination between the primary (30) and secondary MTF's (47).

Into the recess (27) in the extreme threaded end (29) of the primary MTF (30) is placed an insert (26). The end of the insert (26) that enters the recess (27) initially has a square or other polygonal, splined or knurled register (42) that fits into the corresponding recess (35) within the primary MTF (30). Leading from this register (42) is the narrow end of the frusto conical form of the insert (26), the included angle of which is greater than that of its counterpart (27) in the primary MTF (30) by an amount that allows the extreme threaded end (29) of the primary MTF (30) to be forced into the female threads of the tapped blind hole when the insert (26) is drawn into the recess (27) by the secondary MTF (47). When this is accomplished and the lateral movement between the threads of the primary MTF (30) and the tapped blind hole (34) has been eliminated, the frusto conical faces of the insert (26) and recess (27) are touching along the majority of their length. Leading on from the wide end of the frusto conical section (26) is an optional plain cylindrical register (44). This, as mentioned previously, is an aid to concentricity but is not vital to the functioning of the invention. Continuing from this register is an abutment (45) which, as described previously, is an option, and can prevent overtightening.

Along the axis of this insert (26) is a threaded bore (46) of the same diameter and form as the threaded part of the secondary MTF (47). Slots (38) in the end (29) of the primary MTF (30) placed as in the earlier description allow the extreme threaded ends (29) of the primary MTF (30) to expand radially when the secondary MTF (47) is screwed into the insert (26). The polygonal, splined or knurled register (42) at the narrow end of the insert (26) when placed in the corresponding part of the recess (35) at the end of the through bore (22) prevents the insert (26) from rotating when the secondary MTF (47) is screwed into it. As screwing progresses the insert (26) is drawn into the recess (27) but the polygonal, splined or knurled part (42) of the insert (26) never touches the end of the corresponding part (35) of the recess (27) furthest

away from the extreme threaded end (29) of the MTF (30) such that the radial expansion of the extreme threaded end (29) of the primary MTF (30) is fully effected.

As already mentioned the ability of the insert not to be rotated by the screwing action of the secondary MTF in the tapped blind hole and the difficult nut access situation is vital to the assembly and disassembly of the components.

Besides the method described of preventing rotation of the insert there are other methods of performing this technique and some are described later and relate to Figure12

Besides the "nut and bolt" and "tapped hole" situations this invention can also be applied to engineers' studs where either or both ends are required to be secured in position. If the end of the stud screwed into a tapped hole only requires to be secured then the "tapped hole" arrangement can be used. If the end of the stud protruding from the assembly only requires to be secured then the "nut and bolt" method can be used. However, if both ends of the stud are required to be secured then the embodiment is as shown in Figure 10.

The end of the primary engineers' stud (50) that fits into the tapped blind hole (56) has a frusto conical recess (57), the extreme end of which there is an optional chamfer (58) and an optional plain cylinder (59). This plain cylinder (59) leads into the widest end of the frusto conical section (57). The narrow end of this frusto conical section (57) then leads into a square,r polygonal, splined or knurled form (61) and from here running along the full length of the stud axis is a plain bore (62). The end (63) of this plain bore (62) leads into a square, polygonal, splined or knurled form of recess (64) which then leads into the narrow end of a frusto conical recess (54), the wide end of which leads into an optional plain bore (75) which exits the end of the stud via an optional chamfer or radius (76). Circumferentially placed narrow slits (52,53) are cut into the extreme threaded ends of the engineers' stud (50), extending to the plain bore (62) at either end of the stud. These slits can be radiused at the closed ends furthest away from the extreme threaded ends of the studs but are not vital to the functioning of the invention.

Into the frusto conical recess (57) at the end of the stud (50) that screws into the tapped blind hole (56) fits a similarly shaped insert (55). At the widest end of the insert (55) there is an optional abutment (65) and cylindrical register (66) which fits into the widest end of the frusto conical insert (55). The narrow end of this frusto conical insert then leads into a square, polygon, splined or knurled register (67) which then blends into a cylindrical secondary male threaded fastener (68) that fits through the axial plain bore (62) and exits the stud (50) through the other recess (54) for a pre-determined distance. Into this recess (54) at the end of the stud (50) carrying the hexagon nut or similar (51) fits another insert (69) of essentially a frusto conical section. At the widest end of the insert (69) is an optional abutment (70) and cylindrical register (71) which lead into the widest end of the frusto conical insert (69). The narrow end of this frusto conical insert (69) leads into a square, polygonal, splined, or knurled register (72). Along the axis of this insert (69) is a plain bore (73) of the same diameter as the axial bore (62) through the stud (50).

The preferred method of installation and assembly is to firstly locate the insert (55) into the end of the primary stud (50) that screws into the tapped blind hole (56). The insert (69) that fits into the recess (54) at the other end of the stud (50) is placed in position and the threaded end (74) of the secondary male threaded fastener (68) has screwed onto it a secondary hexagon nut (77) or other open female threaded fastener until "finger tight" when both inserts fit snugly into their respective recesses (57,54). Rotation of the inserts (55,69) is unable to take place because of the square, polygonal splined or knurled registers (67,72) that fit into their counterpart recesses (61,64). The primary stud (50) is then screwed into the tapped hole (56) of the component (48) to the recommended torque. The other component (47) to be clamped is then placed into position and the primary female fastener (51) is also tightened to the recommended torque.The secondary female threaded fastener (77) is then tightened to its recommended torque causing both extreme ends of the engineers' stud (50) to be forced into the threads of their female counterparts (56,51) ensuring security and prevention of lateral movement during operation.

Figure 11 shows how the invention can be modified in the "nut and bolt" situation when the nuts, in this case, are of different thicknesses. The inserts (78) are screwed into the recesses (79) by the method already described but the frusto conical angles of the faces are different. In both cases, however, the included angle of the insert is greater than that of the recess.

Figure 12 shows various forms of insert that can be used in the "tapped hole" situation. They are by no means exhaustive and those skilled in the art could produce many more variations. However, the principle of the insert is to prevent its rotation during assembly and disassembly of the insert when used in the "tapped hole" situation.

Diagram A shows a pin or dowel (80) inserted or welded to the insert (81) that fits into one of the axial slots in the recess of the primary fastener. During assembly the pin or dowel (80) prevents the insert (81) from rotating. As many pins or dowels as deemed necessary are used. This method of anti-rotation is useful if the parts of the insert at either end of the frusto conical portions are cylindrical. Along the axis of the insert runs a tapped bore (86) into which is screwed the secondary MTF.

Diagram B is similar to Diagram A except that instead of a pin or dowel a "fin" (82) is utilised. The method of operation is the same as described in Diagram A.

Diagrams C and D show a square section (83) of the narrow end of the fruso conical section. This square section could be any polygonal shape but the object is to fit into its counterpart in the primary MTF to prevent rotation during assembly and disassembly.

Diagrams E and F show the tapered section of the insert (84) to be pyramidal with the section at the narrow end of the pyramid being square (85), although any polygonal section could be utilised. A similar arrangement is shown in Figure 14H.

CLAIMS

1. A securing method for any male threaded fastener and its female counterpart, holding components together, that eliminates the lateral movement of interengagement between them and maintains a high clamping load either in a "nut and bolt" or "blind hole" situation when they are screwed together to the recommended torque, comprising a recess in the threaded end of the male threaded fastener extending from the engaged end of the threaded portion to a position not exceeding the end of the female threaded fastener furthest away from the engaged end of the male threaded fastener whose form is frusto conical having plain cylindrical bores at either end of the frusto conical shape, and a bored and threaded extention from the smaller diameter bore, along the axis, in the "nut and bolt" situation, the largest diameter bore being at the engaged end of the threaded part of the male threaded fastener and having a radius or chamfer on the internal edge into which are introduced narrow radial slots radiused at the end furthest away from the engaged end of the male threaded fastener to prevent them acting as stress raisers, evenly spaced circumferentially and extending longitudinally to positions not exceeding the end of the recess furthest away from the engaged end of the male threaded fastener, and an insert, which has substantially the same form as the recess having a cylindrical register of smaller diameter than the smallest diameter of the frusto cone leading into the frusto cone which then leads into another cylindrical register which has a slightly larger diameter than the larger diameter cylindrical bore in the recess in the end of the male threaded fastener, which then links with an abutment whose surface area in contact with the larger diameter cylindrical register is greater than that of the larger diameter cylindrical register, that is introduced into the recess by screwing past the radius or chamfer, until the cylinder and bore are fully engaged causing the slotted end of the male threaded fastener to splay outwards concentrically due to the included angle of the frusto cone of the insert being larger than the included angle of the frusto conical shape in the recess, and so eliminating the lateral movement between the male and female threaded components while ensuring that overtightening does not take place because of the abutment and ensuring that the location of maximum stress is not encroached by any elements of the recess.

2. A securing method according to claim 1 characterised by the insert having an integral cylindrical projection from the smaller diameter cylindrical register of which the outer surface is threaded for a distance approximating to one diameter of the cylindrical projection and adapted to be screwed into a tapped hole along the axis of the male threaded fastener at the end of the recess leaving the small diameter cylindrical bore, the insert being provided at the abutment end with either a raised polygonal driving means such as a hexagon head, or a sunken polygonal driving means such as a hexagon socket.

3. A securing method according to claim 1 characterised in that the male threaded fastener has a through bore leading from the recess to the other end of the male threaded fastener and that through the bore from the end opposite the frusto conical and cylindrical recess is introduced a secondary male threaded fastener which engages a threaded hole through the axis of the insert and which is capable of being rotated such that with increased rotation the insert is drawn into the frusto conical and cylindrical recess until the lateral distance between the mating threads of the primary

male threaded fastener and its corresponding female counterpart is eliminated with the abutment preventing overtightening.

4. A securing method according to claim 3 characterised by the female counterpart of the primary male threaded fastener being a tapped hole having a "blind" end or an "open" fastener such as a nut.

5. A securing method according to claim 1 characterised by the primary male threaded fastener having two threaded ends and both ends being engaged with female threaded counterparts one of which is a tapped hole the other of which is an open counterpart such as a nut, with the primary male threaded fastener having a bore along its axis from one recess to the other through which runs a secondary male threaded fastener having an insert attached to the end which fits into the tapped hole and a threaded portion at the opposite end, which fits through another insert, onto which is screwed a secondary female threaded fastener which causes both inserts to be activated resulting in the thread clearances between both ends of the primary male threaded fasteners and their counterparts to be eliminated.

6. A securing method according to claim 1 whereby the male fastener and its counterpart could be non threaded or plain with the extreme end of the male fastener still being allowed to expand into its female counterpart.

7. A securing method according to claims 1 and 2 whereby the shapes of insert and recess could be pyradamidal, splined, knurled or of other polygonal form but being of taper form whereby the included angle of the insert is greater than that of the recess to allow the threads of the split end of the MTF to expand outwards into the threads of the FTF and to prevent rotation of the insert during assembly and disassembly.

8. A securing method whereby the optional plain cylinders and registers in the recesses and inserts could be of square, splined, knurled or other polygonal shapes to prevent rotation of the insert during assembly and disassembly in the "tapped hole" situation.

9. A securing method according to claims 5-8 whereby a pin could be introduced into the frusto conical face of the insert and slides into one of the slots on the recess and prevents the insert from rotating in the "tapped hole" situation.

10. A securing method as in claims 5-9 whereby the pin could be substituted by a fin or fins that are attached to the insert and which fit into the slots in the end of the recess to prevent rotation of the insert during assembly and disassembly.

11. A securing method according to claim 2 whereby the insert comprises two parts, one part being of frusto conical shape having an anti-rotational polygonal or splined register at the narrow end of the frusto cone and a second part being a male threaded fastener that fits through an axial bore of the insert and screws into its counterpart in the primary MTF.

12.A securing method according to all previous claims whereby those skilled in the art can produce any number of permutations and combinations of the inserts and recesses described to produce a functional form of the invention.

Amendments to the claims have been filed as follows

1/ A threaded device for assembling and disassembling sections of engineering assemblies, that are subject to vibration and impact, that resists self loosening and maintains the pre-determined load at the sections interface, whereby a male threaded fastener has introduced into its threaded end a slotted and tapped recess whose basic form is frusto conical into which is screwed an insert of substantially the same form, both items producing a unit which is passed through the assembly sections to be engaged by an open female threaded fastener which passes over the insert after which it is torqued onto the male threaded fastener to a pre-determined value, allowing the segments in the end of the male threaded fastener created by the slots, to expand radially and be forced into the threads of the female threaded fastener as the insert is screwed into the recess to its pre-determined torque value, the recess comprising plain cylindrical bores of different diameters at either end of a frusto cone that extends axially from the wide end at the extreme threaded end of the male threaded fastener inwardly to the narrow end from where the small cylindrical bore blends axially and forwardly with an internally threaded blank end cylinder whose diameter approximates to its length, the plain cylindrical bores ensuring alignment of the insert and concentricity of radial expansion of the segments which occurs due to the presence of axially directed slots, positioned circumferentially around the recess and radiused at the forward end to offset any excess stresses raised during the expansion, which extend forwardly to the most rearward position only of the internally threaded cylinder ensuring there is no weakening of this cylinder that is used to accept the externally threaded spigot of the insert, which is also characterised by having a frusto conical basic form and plain cylinders that fit into the recess, aiding alignment and concentricity of expansion, as the externally threaded spigot, whose dimensions are compatible with the internally threaded cylinder, is screwed into the internally threaded cylinder in the recess, and an abutment, adjacent the large diameter cylinder through which the driving recess passes into the rearward end of the insert, used to prevent overtightening of the insert whose outer diameter is smaller than the inner diameter of the female threaded fastener which engages the unit of the male threaded fastener and insert after they have been passed through the openings of the assembly sections such that if the male threaded fastener is a bolt or other fastener with a head, the head bears against one side of the section allowing the threaded end to protrude from the other surface before the female threaded fastener is screwed to it, over the insert, and torqued to its pre-determined value ensuring the first thread of engagement does not exist rearwardly of the internally threaded cylinder, so allowing the maximum pre-determined load to be at the maximum cross sectional stress area of the threaded part of the male threaded fastener, and the last thread of engagement to be inward of the extreme end of the male threaded fastener by two threads before the insert, whose frusto cone included angle is greater than that of the frusto conical part of the recess, is tightened to its pre-determined value, using the driving mechanism in its wide end, and has face to face contact with the frusto conical portions of the recess such that the threads on the outside of the segments of the male threaded fastener are expanded and forced into their female counterparts, increasing the frictional force between the engaged threads, eliminating the lateral inter engagement spacings at the extreme threaded end of the male threaded fastener and ensuring the outer diameter of the extreme end of the male threaded fastener exceeds that of the outer thread diameter of the female fastener thus eliminating rotational loosening.

2/ A threaded securing device according to claim 1 where the insert consists of a bolt and a frusto conical recess with a plain bore along the axis through which the bolt passes to be screwed into the internally threaded cylinder of the recess.

3/ A threaded securing device according to claim 1 whereby the head of the insert is modified to accept a cover that prevents the ingress of dirt and moisture to the recess.

The Patent Office

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Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F2H

Int Cl (Ed.6): F16B 39/02

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	WO 96/23142 A1	(CHADBURN) see whole document	1 and 2
X	US 4874275	(GOTMAN) see whole document	1 and 2

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